Question			Answer	Marks	Guidance	
1	(i)		Mean $= \frac{59972}{40} = 1499$ Condone full answer of 1499.3 (despite over-specification rule) $Sxx = 96767028 - \frac{59972^2}{40} = 6851008$ $s = \sqrt{\frac{6851008}{39}} = \sqrt{175667} = 419$ NB Full answer is 419. 1263 (but only allow to 4sf due to over-specification rule)	B1 M1 A1 [3]	CAO Ignore units For S*xx* CAO ignore units	NB Allow 1500 NB Answer must be decimal M1 for 96767028 - 40 × their mean^2 BUT NOTE M0 if their $S_{xx} < 0$ For s^2 of 176000 (or better) allow M1A0 with or without working For RMSD of 414 (or better) allow M1A0 provided working seen For RMSD^2 of 171000 (or better) allow M1A0 provided working seen For use of 1499: S*xx* = 6886988, s^2 = 176589, s = 420.225, RMSD = 414.9 For use of 1500: S*xx* = 6767028, s^2 = 173513.5, s = 416.549, RMSD = 411.3 Give same credit to answers as for correct answers
1	(ii)		New mean = (0.163 × 1499) + 14.5 = £258.84 (No penalty for giving to 5sf as this is an exact sum of money) New sd = 0.163 × 419 = £68.30	B1 M1 A1 [3]	FT their mean provided answer is positive FT their sd for M1 and A1 Allow £68.29 to £68.32 Allow 68.3	If candidate 'starts again' only award marks for CAO Allow £259 or £259.00 from 1500 or £258.89 from 1499.3 Condone 258.8 and 258.9 Accept answers rounded to 3 sf or more eg £258.80, £258.90 Or for 0.163×419.1 oe Do not penalise lack of units in mean or sd Deduct at most 1 mark overall in whole question for over-specification of either mean or SD or both

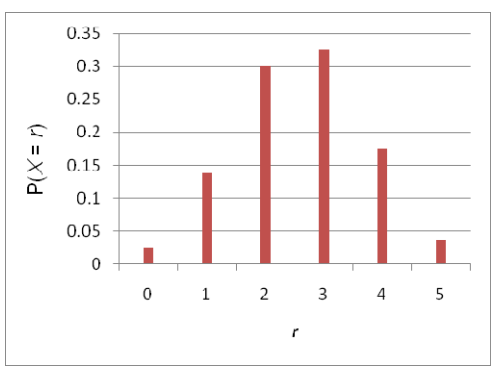
2	**(i)**		$P(X = 6) = 1 - P(X < 6) = 1 - \left(\frac{5}{6}\right)^3 = 1 - \frac{125}{216}$	M1	For $\left(\frac{5}{6}\right)^3$	
				M1	For $1-\left(\frac{5}{6}\right)^3$	
			$= \frac{91}{216}$	A1	**NB ANSWER GIVEN**	
				[3]		
			OR: $= \left(\frac{1}{6}\right)^3 + 3\times\left(\frac{5}{6}\right)\times\left(\frac{1}{6}\right)^2 + 3\times\left(\frac{5}{6}\right)^2\times\left(\frac{1}{6}\right)$	M1	For second or third product term	Correct, including ×3 or probabilities seen on correct tree diagram
				M1	For attempt at three terms	With no extras, but allow omission of ×3
			$= \frac{91}{216}$	A1	**NB ANSWER GIVEN**	NB Zero for 1 – (sum of probs given in part (ii))
			OR: $1 + 15 + 75$	M1	for 15 or 75 seen	
			$= \frac{1+15+75}{216}$	M1		

			$= \frac{91}{216}$	A1	**NB ANSWER GIVEN**	
2	**(ii)**		E(X) = $\left(1\times\frac{1}{216}\right)+\left(2\times\frac{7}{216}\right)+\left(3\times\frac{19}{216}\right)+\left(\ \times\frac{37}{216}\right)+\left(\ \times\frac{61}{216}\right)+\left(\ \times\frac{91}{216}\right)$	M1	For Σrp (at least 3 terms correct)	
			$= \frac{1071}{216} = \frac{119}{24} = 4.96$ (exact answer 4.9583333)	A1	CAO	Accept fractional answers Do not allow answer of 5 unless more accurate answer given first
			E(X^2) = $\left(1\times\frac{1}{216}\right)+\left(4\times\frac{7}{216}\right)+\left(9\times\frac{19}{216}\right)+\left(16\times\frac{37}{216}\right)+\left(25\times\frac{61}{216}\right)+\left(36\times\frac{91}{216}\right)$	M1*	For $\Sigma r^2 p$ (at least 3 terms correct)	Use of $E(X-\mu)^2$ gets M1 for attempt at $(x-\mu)^2$ should see $(-3.96)^2$, $(-2.96)^2$, $(-1.96)^2$, $(-0.96)^2$ 0.04^2, 1.04^2, (if E(X) wrong FT their E(X)) (all 6 correct for M1), then M1 for $\Sigma p(x-\mu)^2$ (at least 3 terms correct) Division by 6 or other spurious value at end and/or rooting final answer gives max M1A1M1M1A0, or M1A0M1M1A0 if E(X) also divided by 6.
			$= \frac{5593}{216} = 25.89$ Var(X) = 25.89.. – 4.958…^{2}	M1* dep	for – their (E(X))²	
			= 1.31 Accept answers in range 1.28 to 1.31 with correct working or 2261/1728 (Exact answer 1.308449…)	A1	FT their E(X) provided Var(X) > 0	Do not FT E(X) = 5 if full marks given for E(X) Deduct at most 1 mark for over-specification of either mean or variance or both Unsupported correct answers get 5 marks (Probably from calculator)
				[5]		

Question			Answer	Marks	Guidance	
3	(i)		$k + 0.01 + k + 0.04 + k + 0.09 + k + 0.16 + k + 0.25 = 1$ $5k + 0.55 = 1$ $k = 0.09$ r | 1 | 2 | 3 | 4 | 5 P($X = r$) | 0.1 | 0.13 | 0.18 | 0.25 | 0.34	M1 A1 B1 **[3]**	For equation in k NB **Answer Given** Complete correct table	Allow substitution of $k = 0.09$ to show probabilities add to 1 with convincing working Must tabulate probabilities, though may be seen in part(ii)
	(ii)		E(X) = $(1\times0.1)+(2\times0.13)+(3\times0.18)+(4\times0.25)+(5\times0.34)$ = 3.6 E(X^2) = $(1\times0.1)+(4\times0.13)+(9\times0.18)+(16\times0.25)+(25\times0.34)=14.74$ Var(X) = $14.74 - 3.6^2$ = 1.78	M1 A1 M1* M1* dep A1 **[5]**	For Σrp (at least 3 terms correct Provided 5 reasonable probabilities seen. CAO For Σr^2p (at least 3 terms correct) for – their (E[X])² FT their E(X) provided Var(X) > 0 CAO	If probs wrong but sum = 1 allow max M1A0M1M1A1. If sum ≠ 1 allow max M1A0M1M0A0 (provided all probabilities ≥0 and <1) No marks if all probs =0.2 . Use of E$(X-\mu)^2$ gets M1 for attempt at $(x-\mu)^2$ should see $(-2.6)^2$, $(-1.6)^2$, $(-0.6)^2$, 0.4^2, 1.4^2, (if E(X) wrong FT their E(X)) (all 5 correct for M1), then M1 for $\Sigma p(x-\mu)^2$ (at least 3 terms correct with their probabilities) Division by 5 or other spurious value at end and/or rooting final answer gives max M1A1M1M1A0, or M1A0M1M1A0 if E(X) also divided by 5. Unsupported correct answers get 5 marks (Probably from calculator)

4	**(i)**		<table><tr><td>r</td><td>2</td><td></td><td></td><td></td></tr><tr><td>P($X = r$)</td><td>k</td><td>8k</td><td>15k</td><td>24k</td></tr></table>	B1	For correct table (ito k or correct probabilities 0.06, 0.16, 0.30, 0.48)	
			$3k + 8k + 15k + 24k = 1$	M1		For their four multiples of k added and =1.
			$k = 0.02$	A1 **[3]**	or $k = 1/50$ (with or without working)	Allow M1A1 even if done in part **(ii)** – link part **(ii)** to part **(i)**

4	**(ii)**		$E(X) = (2\times0.06)+(3\times0.16)+(4\times0.30)+(5\times0.48) = 4.2$	M1	For Σrp (at least 3 terms correct Provided 4 reasonable probabilities seen.	If probs wrong but sum = 1 allow full marks here. If sum ≠ 1 allow max M1A0M1 M0A0 (provided all probabilities between 0 and 1)
			or 21/5	A1	cao	Or ito k NB $E(X) = 210k$, $E(X^2) = 924k$ gets M1A0M1M0A0. $E(X) = 210k$, Var $(X) = 924k – (210k)^2$ gets M1A0M1M1A0.
			$E(X^2) = (4\times0.06)+(9\times0.16)+(16\times0.30)+(25\times0.48) = 18.48$	**M1**	Fo Σr^2p (at least 3 terms correct)	
			$\text{Var}(X) = 18.48 – 4.2^2$	M1	dep for – their $E(X)^2$	
			$= 0.84 = 21/25$	A1	FT their $E(X)$ provided $\text{Var}(X) > 0$ (and of course $E(X^2)$ is correct)	Use of $E(X – \mu)^2$ gets M1 for attempt at $(x – \mu)^2$ should see $(–2.2)^2$, $(–1.2)^2$, $(–0.2)^2$, 0.8^2, (if $E(X)$ wrong FT their $E(X)$) (all 4 correct for M1), then M1 for $\Sigma p(x – \mu)^2$ (at least 3 terms correct with their probabilities) Division by 4 or other spurious value at end gives max M1A1M1M1A0, or M1A0M1M1A0 if $E(X)$ also divided by 4. Unsupported correct answers get 5 marks
				[5]		

Question			Answer	Marks	Guidance
5	(i)		$P(X = 0) = 0.4 \times 0.5^4 = 0.025$ **NB ANSWER GIVEN**	M1 A1 **[2]**	For 0.5^4
	(ii)		$P(X = 1) = (0.6 \times 0.5^4) + (4 \times 0.4 \times 0.5 \times 0.5^3)$ $= 0.0375 + 0.1 = 0.1375$ **NB ANSWER GIVEN**	M1* M1* M1* dep A1 **[4]**	For 0.6×0.5^4 seen as a single term (not multiplied or divided by anything) For $4 \times 0.4 \times 0.5^4$ Allow 4×0.025 Watch out for incorrect methods such as (0.4/4) 0.1 **MUST** be justified For sum of both , dep on both M1's
	(iii)			G1 G1 **[2]**	For labelled linear scales on both axes Dep on attempt at vertical line chart. Accept P on vertical axis For heights – visual check only but last bar taller than first and fifth taller than second and fourth taller than third. Lines must be thin (gap width > line width). All correct. Zero if vertical scale not linear Everything correct but joined up tops G0G1 MAX Everything correct but f poly G0G1 MAX Everything correct but bar chart G0G1 MAX Curve only (no vertical lines) gets G0G0 Best fit line G0G0 Allow transposed diagram

Question			Answer	Marks	Guidance
5	(iv)		'Negative' or 'very slight negative'	E1 **[1]**	E0 for symmetrical but E1 for (very slight) negative skewness even if also mention symmetrical Ignore any reference to unimodal
	(v)		$E(X) = (0\times0.025) + (1\times0.1375) + (2\times0.3) + (3\times0.325) + (4\times0.175) + (5\times0.0375)$ $= 2.6$ $E(X^2) = (0\times0.025) + (1\times0.1375) + (4\times0.3) + (9\times0.325) + 16\times0.175) + (25\times0.0\ \ 75) = 0 + 0.1375 + 1.2 + 2.925 + 2.8 + 0.9375 = 8$ $\text{Var}(X) = 8 - 2.6^2$ $= 1.24$	M1 A1 M1* M1* dep A1 **[5]**	For Σrp (at least 3 terms correct) CAO For $\Sigma r^2 p$ (at least 3 terms correct) for – their E(X)² FT their E(X) provided Var(X) > 0 USE of $E(X-\mu)^2$ gets M1 for attempt at $(x-\mu)^2$ should see $(-2.6)^2$, $(-1.6)^2$, $(-0.6)^2$, 0.4^2, 1.4^2, 2.4^2 (if $E(X)$ correct but FT their $E(X)$) (all 5 correct for M1), then M1 for $\Sigma p(x-\mu)^2$ (at least 3 terms correct) Division by 5 or other spurious value at end gives max M1A1M1M1A0, or M1A0M1M1A0 if $E(X)$ also divided by 5. Unsupported correct answers get 5 marks.
	(vi)		P(Total of 3) = $(3\times0.325\times0.025^2) + (6\times0.3\times0.1375\times0.025) + 0.1375^3 = 3\times0.000203 + 6\times0.001031 + 0.002600 =$ $0.000609 + 0.006188 + 0.002600 = 0.00940$ $(= 3\times13/64000 + 6\times33/32000 + 1331/512000)$	M1 M1 M1 A1 **[4]**	For decimal part of first term 0.325×0.025^2 For decimal part of second term $0.3\times0.1375\times0.025$ For third term – ignore extra coefficient All M marks above depend on triple probability products CAO: AWRT 0.0094. Allow 0.009 with working.